2. Place a small amount of Loctite 454 Adhesive into the magnet recess. Immediately place the replacement magnet into place (adhere to either side of the magnet). Be sure to wipe away excess adhesive which may have squeezed onto the top side of the magnet.

Caution Loctite 454 Adhesive contains cyanoacrylate. Observe all necessary precautions as specified by the manufacturer for the safe handling of this adhesive.

3. Allow the bond to dry as specified by the manufacturer.
4. Without a container in the Monitor, completely close the display so that the magnets make contact with the attraction plates. Lift up on the display to verify that the magnet is still bonded to the bezel enclosure.

Rear Enclosure

The rear enclosure provides protection to the main PCB from fluids, contamination and impact. Attached to the rear enclosure is the rear control panel door, rear control panel label, information label, and battery doors. The rear enclosure is directly attached to the front enclosure.

Testing the Rear Enclosure

Visually inspect the rear enclosure, if the rear enclosure is damaged or cracked, it must be replaced.

Note: If the rear enclosure is to be replaced, it is necessary to transfer the Monitor's serial number to the replacement case.

Removing the Rear Enclosure

Equipment Required

- No. 2 Phillips screwdriver
- Needle nose pliers

Procedure

Note: Review the contents of the Rear Enclosure replacement parts kit (see the Replacement Parts List on page 64), to confirm which parts you may need to keep/discard during disassembly.

1. Ensure that the Monitor is turned off. Remove the battery doors and battery packs.
2. Place the Monitor face down on a soft surface.
3. Remove the hinge pins which connect the display assembly to the Monitor enclosure. Each hinge pin has an e-style snap ring mounted on it. The snap ring must be removed in order to pull out the hinge pin. The snap ring must be oriented properly, as illustrated in Figure 56 in order to remove it. If the snap ring is not properly oriented, rotate it into correct position by using a small flathead screwdriver.
4. Using a needle-nose pliers, remove both snap rings.
5. After removing both snap rings, pull out both hinge pins as illustrated in Figure 57.

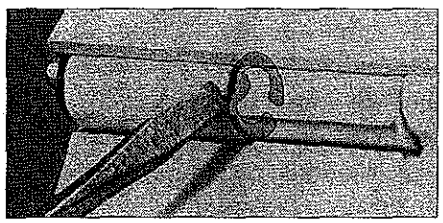


Figure 56

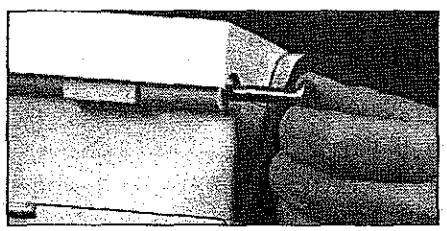


Figure 57

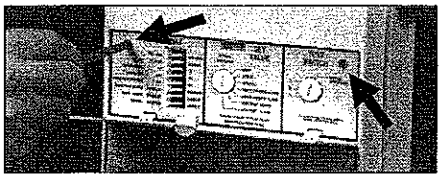


Figure 58

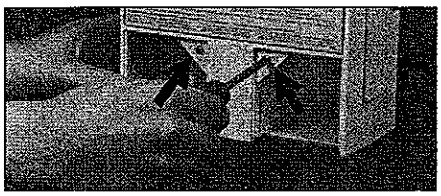


Figure 59

6. Open the rear control panel door. Ensure that both the SET VALUE and the TEST SWITCH rotary knobs are set to NORMAL OPERATION, then pull gently to remove the rotary knobs.
7. Remove the four (4) 6-32x3/8" Phillips pan-head screws as illustrated in Figures 58 and 59. Close the rear control panel door.
8. Pull straight up on the rear enclosure (see Figure 60) to separate it from the front of the Monitor. Arrow in Figure 60 shows how to position your fingers so that the panel insert does not fall out of the rear enclosure.

Installing the Rear Enclosure

Equipment Required

- No. 2 Phillips screwdriver
- Needle nose pliers

Procedure

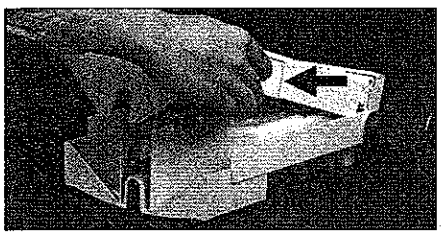


Figure 60

1. On a small 1" x 1/2" label or piece of paper clearly write down the Monitor serial number and model number.

Note: These numbers must fit into the small window on the information label (see circled area in Figure 61).

2. Remove the adhesive backing from the information label. Carefully place the label/paper into the blank section of the label. Ensure that the text is visible from the printed side of the label.
3. Carefully place the information label on to the rear enclosure as illustrated in Figure 61.
4. Remove the adhesive backing from the rear control panel label. Carefully place the label onto the rear enclosure as illustrated is Figure 61.

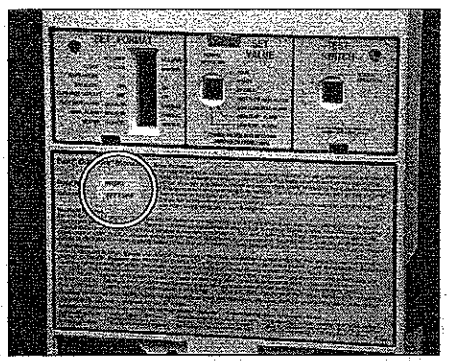


Figure 61

5. Attach the rear door to the enclosure by carefully pushing the rear door hinge tabs into the rear enclosure hinge slots (see Figure 62).
6. Place the rear enclosure onto the front enclosure, ensuring that the plastic blank insert is held into position as illustrated by the arrow in Figure 60. Install the rear enclosure by installing the four (4) 6-32x3/8" Phillips pan-head screws (see Figures 58 and 59).

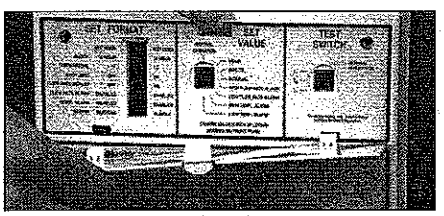


Figure 62

7. Ensure that the display assembly is correctly oriented so that the holes for the hinge pins are clear.
8. Insert the two hinge pins (see Figure 57), and replace the snap rings.
9. Insert and connect the battery packs and install the battery doors.
10. Stand the Monitor up, open the rear control panel door and reattach the SET VALUE and TEST SWITCH rotary knobs, ensuring that the arrows on the two knobs are oriented in the same direction that they were in when they were removed.
11. Perform the Functional Checkout procedure (see page 7) to ensure that all display and general Monitor functions are working properly.

Battery Assembly

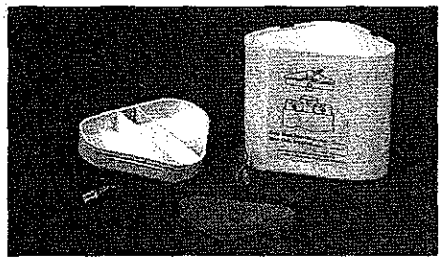


Figure 63

The battery assembly houses 3 D-cell alkaline batteries and provides electrical connection to the main PCB. The battery assembly rests inside the front and rear enclosure recess, and is held in place by the battery door. Located on the bottom of each battery assembly is a foam pad. When assembled, the pad pushes up on the housing, forcing the battery assembly to remain closed tight against the battery door.

Testing the Battery Assembly

Equipment Required

- Multimeter

Procedure

1. Visually inspect the battery assembly, if the battery assembly is damaged or cracked, it must be replaced.

Note: If the batteries are to be replaced, record the date of installation on the battery label.

2. Using a voltage meter, check to see if the voltage is > 3.0V. If the wiring is not suspect, the batteries must be replaced.
3. Open the top cover of the battery assembly and verify that the batteries are not damaged, the batteries are inserted with the proper polarity, and that the battery cable connector is attached to the contacts inside the battery assembly.
4. If there is any damage to the batteries, they must be properly discarded and replaced.
5. If the battery cable connector is damaged, the battery assembly must be replaced.

Assembling the Battery Assembly

Procedure

1. Inspect each component of the battery assembly: battery assembly cover, battery assembly housing, battery cable connector. Replace each damaged component as necessary.
2. When connecting the battery cable connector, ensure that red connector is attached to the battery cover, and the black connector is attached to the housing.
3. To attach the foam pad, remove the adhesive backing and adhere the pad to the bottom of the battery housing.

Details of Electrical Operation

This section of the manual provides a technical description of how the Bard *CritiCore Monitor* operates.

Caution: The Bard *CritiCore Monitor* main and display PCB's (printed Circuit Boards) are specialized multi-metal and layered boards. Reworking a PCB can easily damage other components and/or the board itself. This damage may cause intermittent or permanent malfunction of the Monitor. It is not recommended that any[†] board level repair be performed outside a Bard designated repair facility. Replacement PCB's are available through Bard in the event that they are needed (see the Replacement Parts List on page 64). The following section(s) detail the electronic functions of the Bard *CritiCore Monitor.* These details are provided so that the reader can isolate a problem to or from the PCB.

[†]One noted exception is the replacement of F1 fuse

Fluid Output Electronics

The volume in the disposable container is determined by measuring the height of the fluid in the container and calculating the volume based on the shape of the container. The transducer driver and receiver circuits are detailed on the Main Schematic (schematics are located at the end of the manual). The ultrasonic transducer in the Monitor is capable of operation at high voltages. The higher the applied voltage, the larger (bigger amplitude) the return signal will be. The high voltage charge is developed by charging inductor L1 through FET Q14 while the CHARGE line is on (logic "high'). When CHARGE is turned off, Q14 is shut off, and the voltage on it's drain rises rapidly, charging C64 to approximately 150V through D12 and D13. IL1 is charged less when a repetitive stable echo signal is received. This is done by varying the duration of the CHARGE pulse between 120µs and 69µs.

About 45µs after CHARGE is off, STRTXM is turned on (see Figure 64). This turns on FET's Q12 and Q13, which short C64 to ground. This generates a very fast, negative voltage pulse that is coupled to the transducer (connected to terminals T1 and T2) via D7. D5 and D6 protect the receive amplifier from the high transmit voltages. U32 amplifies the received signal and the surrounding circuit provides a bandpass filter. U10 is a comparator that is set to provide a logic level output when an echo is received. The threshold voltage is determined by the network that is attached to pin 3. The threshold is pulled higher during the transmit pulse, and then decays toward a lower level over time as C60 discharges. The echo is attenuated by the liquid and decays with time. Since C60 is decreasing with time as well, the receiver becomes more sensitive.

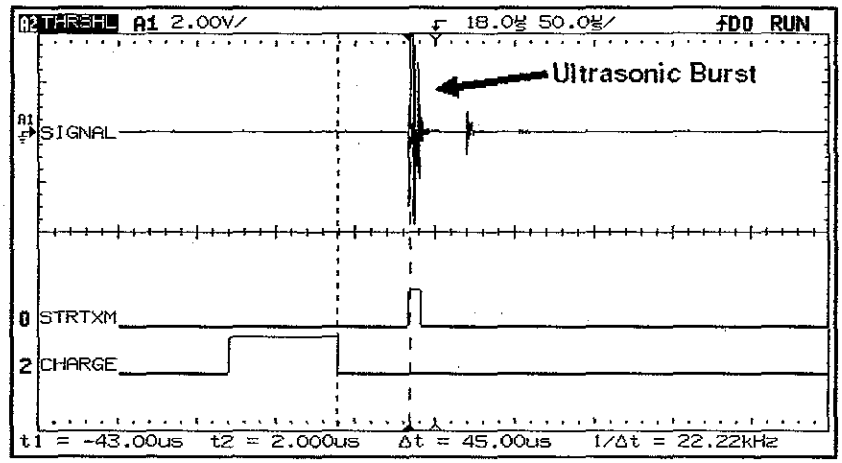


Figure 64

The "time of flight" of the ultrasonic echo is measured by counters U7 and U8. The STRTXM signal that fires the transducer also resets the counters and sets a flip-flop made up of U15A and U15D. As long as the flip-flop is set, the 16MHz clock is enabled to the counters. When ECHO is turned on, signifying a valid echo, the flip-flop is reset, shutting off the clock (see Figure 65). The value of the counter is then read by the microcontroller via U12 and U13.

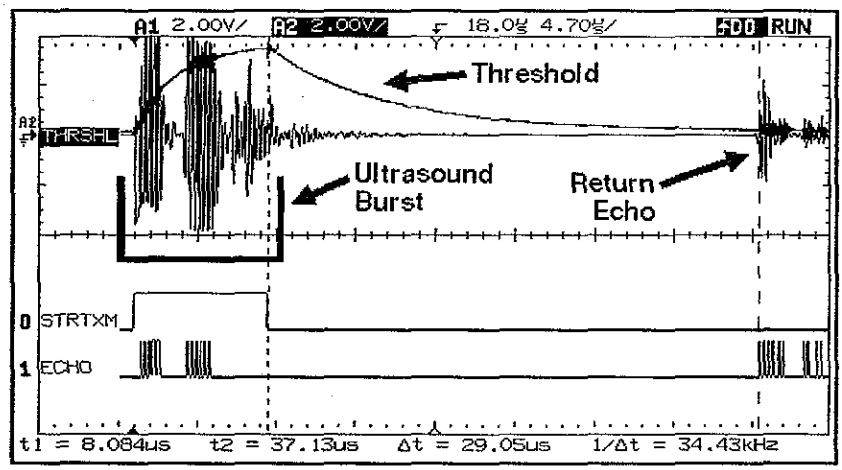


Figure 65

Temperature Measurement Electronics

The temperature sensor is a 400-series thermistor embedded within the Foley catheter. It has a nominal resistance of roughly 1.6K at 33°C. U35 amplifies the signal, and provides for an offset adjustment. The signal is then digitized by U34, which is read by the microcontroller at the SPI port. The value is converted into a temperature according to the temperature vs. resistance data supplied by the thermistor manufacturer.

Microcontroller Details

The 68HC705C9 series microcontroller has a total of 16K of memory, including 15,932 Bytes of EPROM, and 352 Bytes of RAM. In this application Port A is configured as a data bus. Ports B and C provide control signals to the peripheral devices. The controller runs at 4MHz, which is derived from the 16MHz clock used for timing in the volume measurement circuitry.

Display Electronics

The display is a custom LCD (Liquid Crystal Display) that is a combination of six segmented areas for displaying numbers and enunciators that are used to indicate data, error conditions and operating modes. It is controlled by U1, which is a Hitachi HD61604 LCD controller chip. It is connected to the microcontroller bus by a cable to the main board.

The display also provides backlighting if enabled by a configuration switch (C1 of SW4) on the main board. It is turned on for 30 seconds after any of the membrane switches are pressed. The display board has the inverter required to provide AC power to the EL panel backlight. The display board also contains U3, which provides a gated oscillator to drive a piezo type beeper that is used for alarm conditions. ISO1 is a reflective optical sensor used to detect the presence of a disposable container.

Keyboard Electronics

The membrane switch is a multi-layered label containing 6 contact switches. The six keys are simple contact closures to a common line.

Power Management

To maximize battery life, only those portions of the CritiCore Monitor circuitry actually being used are supplied power. The microcontroller, real time clock, and oscillator always have some power applied. Four times a second, the other circuits are powered up briefly, a measurement is taken, and then they are shut off. This is done by the real time clock, which is programmed to generate an interrupt (at TP4) which turns on the microcontroller.

There are nine separate power control blocks. Refer to the POWER CONTROL BLOCK DIAGRAM to see how they are interrelated. Except for the microcontroller that is turned on by the real time clock, they are all under the control of the microcontroller.

Another technique that is employed to maximize battery life is that the basic Vcc supply is only loosely regulated. It tracks the battery voltage down from 4.8V with a new battery until it reaches 3.3V. At that point a charge pump (C57) is activated to maintain that level until the batteries are exhausted. When the battery drops to 2.6V, the low battery detector comes on and signals the processor to turn on the *Low Battery* status indicator. When the battery drops to 2.2 V, the Monitor shuts off. At this point RAM memory contents can be maintained, but no measurements are made. A backup capacitor (C27) is provided to allow the battery packs to be changed without losing the RAM contents, as long as the change does not take more than about two minutes.

Electronic Testing and Calibration Procedures

Use these procedures to test the Bard CritiCore Monitor's electronics. After any repair is made, whether by yourself or by Bard, refer to the Functional Checkout (page 7) to verify correct operation before returning the CritiCore Monitor for general use.

The following sections detail:

- Testing the Power Modules (page 46)
- Testing/Replacement of the Fuse (F1) (page 48)
- Testing/Replacement of the Transducer (page 50)
- Testing the Phototransistor (ISO1 on display PCB) (page 53)
- Testing the Tilt Sensor (page 55)
- Testing the Temperature Electronics (page 57)
- Replacement/Calibration of the main PCB (page 58)

Power Modules

If a given function of the Monitor is suspected of a malfunction, first attempt to isolate the problem by performing the Functional Checkout procedure. Once the problem is isolated, verify that the appropriate power supply is functioning properly. To check power supply functions, you must gain access to the main PCB.

Testing the Power Modules

Equipment Needed

- 100MHz dual trace oscilloscope (w/ timebase delay capabilities)
- Precision DC power supply
- Multimeter

Note: Refer to the Power Control Block Diagram for schematic reference (schematics are located at the end of this manual).

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Procedure

1. Remove the rear enclosure per the Removing the Rear Enclosure procedure on page 39.
2. Re-insert the hinge pins to temporarily secure the display module to the enclosure assembly.
3. Stand the Monitor upright.

Note: The Monitor will tend to fall backwards without the rear enclosure attached. You will have to place something under the backside of the Monitor to keep it upright. Be sure that the Monitor is level after it has been secured in an upright position.

4. Configure a precision DC power supply to deliver an output of 4.00V @ 250mA, then turn the supply off. Carefully attach the positive lead to the TP1-+BATT test point on the main PCB. Attach the negative lead of the supply to TP2-GND test point on the main PCB (refer to Main PCB Component Map, page 63).

Caution: If the polarity of the leads are reversed, fuse (F1) will blow. Double-check the polarity of the DC power supply leads before turning the supply on.

5. Turn the power supply and the CritiCore Monitor on.
6. Connect the multimeter in series with the power supply, and set the meter to read average DCmA.
7. Verify that (without the backlight on) the **average** current consumption for the Monitor is <10mA. If the current consumption is > 10mA, there is probably a malfunction on the main PCB. Return the Monitor for service, or replace the main PCB. See the Main PCB section (starting on page 58) for removal, installation, and calibration procedures.
8. Verify that (with the backlight on) the **average** current consumption for the Monitor is <50mA. If the current consumption is > 50mA, there is probably a malfunction on the main PCB. Return the Monitor for service, or replace the main PCB. See the Main PCB section (starting on page 58) for removal, installation, and calibration procedures.
9. Remove the meter. Using an oscilloscope, trigger CH1 on TP4-IRQ (Be sure to ground the probe onto the main PCB logic ground TP2). Adjust the scope accordingly to probe CH2 on the following test points:

Power Supply	Test Point Main PCB	[1]Test Point Display PCB	Minimum Value (V)
+5A	TP5	TP2	3.3
+5B	TP6		3.3
SENSPWR	TP9	Pin 7 on JP1	3.3
+AD	TP30		3.3
[2]SER PWR	TP10		3.3
INV PWR	TP11		2.6
+VT	TP7		6.0
+5C	TP8		2.2
GND	TP2, TP14, TP26, TP31	TP1	0.00

[1]To gain access to the display PCB test points, see page 20 for removal of the Bezel Enclosure.
[2]Measure SER PWR with Communications Module attached to the Monitor.

Note: For information on the pulse width for +5B SENSPWR, etc., refer to the timing diagram located with the schematics at the back of this manual.

Fuse

The fuse (F1) provides over-current protection to the CritiCore Monitor electronics. If F1 is suspected of malfunctioning, (no power on PCB) it must be checked to verify continuity.

Testing the Fuse

Equipment Needed

- Multimeter
- No. 2 Phillips screwdriver

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Procedure

1. Remove the rear enclosure per the Removing the Rear Enclosure procedure on page 39.
2. Ensure that the Monitor is turned off. Locate F1 on the main PCB and connect an ohmmeter across F1.
3. Measure the resistance to verify that F1 < 2Ω.

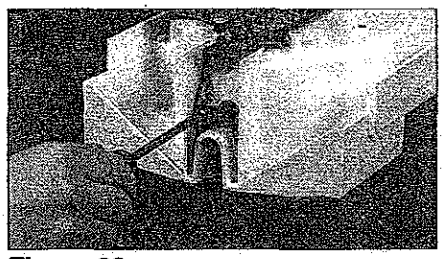


Figure 66

Note: The main and display PCB's are conformally coated, thus ensure that the meter leads are making contact with the component leads. *IF F1 > 2Ω, then F1 must be replaced.*

Removing the Fuse

Equipment Needed

- Desoldering equipment
- No. 2 Phillips screwdriver

Caution : The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

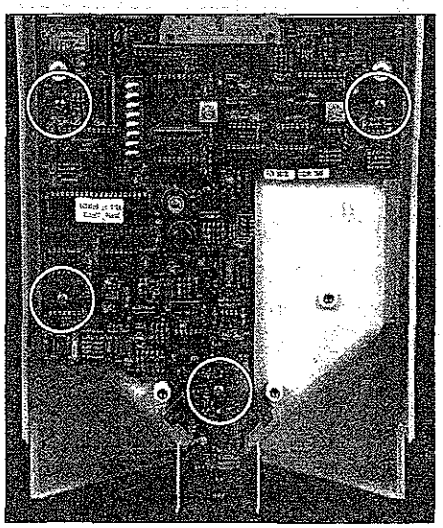


Figure 67

Procedure

1. Remove the rear enclosure per the Removing the Rear Enclosure procedure on page 39.
2. Remove the two (2) 6-32x3/8" Phillips pan-head screws for the transducer, and pull out the transducer and transducer cap from the front enclosure as illustrated in Figure 66.
3. Remove the four (4) 6-32x3/16" Phillips pan-head screws which secure the main PCB to the front enclosure (see circles in Figure 67). Disconnect the display cable from the Main PCB (see Figure 68). Lift up and remove the main PCB.

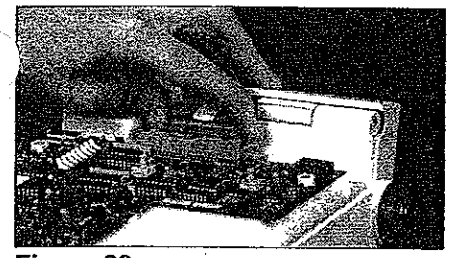


Figure 68

4. Locate the F1 leads on the back side of the PCB and carefully desolder them. Refer to the Main Circuit Board Map on page 63 for the location of F1.

Note: When removing F1, be sure to not damage or remove the PCB pads.

Installing the Fuse

Equipment Needed

- Soldering equipment
- No. 2 Phillips screwdriver

Note: Use an axial lead 0.5 Amp fast-acting fuse only.

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Procedure

1. Solder the replacement fuse into F1 location on the main PCB.
2. Using a non abrasive cloth dampened with 70% Isopropyl Alcohol, be sure to remove any remaining solder flux. Using a brush, apply a light layer of conformal coating onto the leads and pads of the fuse. Allow coating sufficient time to dry as called out by the coating manufacturer before further assembly.

Note: Conformal coatings protect the leads of electronic components from corrosion. Coating the leads of the fuse may prolong the life of the component.

3. Install the four (4) 6-32x3/16" Phillips pan-head screws and attach the main PCB to the front enclosure (see Figure 68). Connect the main PCB to the display PCB.

Note: Ensure that there is no dirt, oil or contamination on either the transducer cap or transducer.

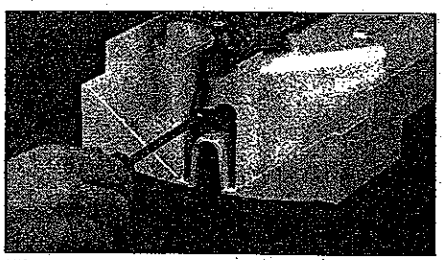


Figure 69

4. Place the transducer cap onto the transducer. Install the two (2) 6-32x3/8" Phillips pan-head screws and attach the transducer/cap to the front enclosure as illustrated in Figure 69. Ensure that the transducer cable will not get pinched when the rear enclosure is attached.
5. Install the rear enclosure per the Installing the Rear Enclosure procedure on page 40.
6. Perform the Functional Checkout procedure to ensure that display and general CritiCore Monitor functions work properly.

Transducer

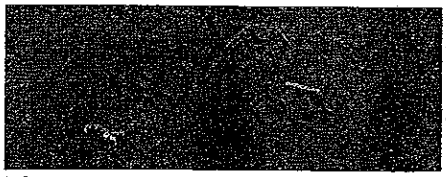


Figure 70

The following procedure outlines the testing necessary to determine if the transducer/transducer circuitry is functioning properly.

Testing the Transducer

Equipment Needed

- 100MHz dual trace oscilloscope with external trigger (w/ time base delay capabilities)
- Precision DC power supply
- 1 disposable CritiCore collection container

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Procedure

1. Remove the rear enclosure per the Removing the Rear Enclosure procedure on page 39.
2. Re-insert the hinge pins to temporarily secure the display module to the enclosure assembly
3. Stand the Monitor upright.

Note: The Monitor will tend to fall backwards without the rear enclosure attached. You will have to place something under the backside of the Monitor to keep it upright. Be sure that the Monitor is standing level after it has been secured in an upright position.

4. Configure a precision DC power supply to deliver an output of 4.00V @ 250mA, then turn the supply off. Carefully attach the positive lead to the TP1-+BATT test point on the main PCB. Attach the negative lead of the supply to TP2-GND test point on the main PCB (see Main PCB Component Map on page 63).

Caution: If the polarity of the leads are reversed, fuse (F1) will blow. Double-check the polarity of the DC power supply leads before turning the supply on.

5. Turn the power supply and CritiCore Monitor *ON.*

Transducer Circuitry Test

6. Configure the oscilloscope per the following guidelines:
   a. Set the main time base to ≈ 50µs/div.
   b. Set the trigger controls for CH2, trigger level ≈ 2.00V, rising edge, normal trigger mode.
   c. Set CH1 and CH2 for 4-600mV/div.
   e. Connect CH1 to TP22-STRTXM (strobe transmit), and CH2 to TP21 (charge).

Note: Refer to Figure 64 on page 43 for an example of correct CHARGE and STRTXM signals.

7. Verify that CHARGE is on (>3.5V) for approximately 69µs.
8. Verify that STRTXM turns on approximately 45µs after CHARGE turns off.

   If the signals do not match the requirements listed in steps 7 and 8, then the main PCB is defective. Return unit to Bard for repair or refer to Replacement Parts List on page 64. See the Main PCB section on page 58 for removal and installation procedures.

Main Bang Response Test

9. Configure the oscilloscope per the following guidelines:
   a. Set the main time base to ≈ 5µs/div.
   b. Set the trigger controls for EXT, trigger level ≈ 2.00V, rising edge, normal trigger mode.
   c. Set CH1 and CH2 for 4-600mV/div.
   d. Set both CH1 and CH2 onto the same graticule (-1.00V).
   e. Connect CH1 to TP23-THRESH (Threshold), and CH2 to TP24 (echo signal).
   f. Connect EXT probe to TP22-STRTXM (strobe transmit).
10. With no container in the Monitor, turn the Monitor on. Ensure that the transducer cap is free from dirt or oil. This test will confirm that the transducer firing circuitry is working properly.

Echo with 50 ml Test

11. Add 50ml of water to the disposable container. This test will confirm that the transducer receiving circuitry is working properly for small volumes.
12. Verify that there is an echo (>180mV) pulse ≈29µs past the falling edge of STRTXM (see Figure 71).

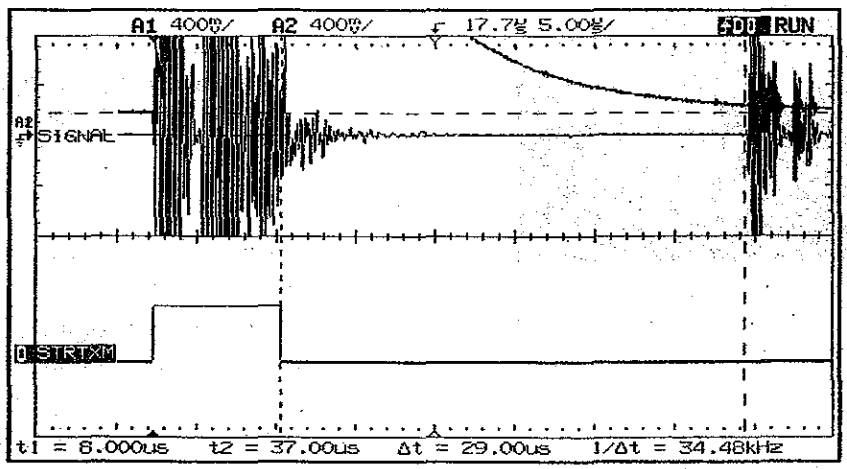


Figure 71

If there is no echo (>180mV) around 29µs, this may be an indication of a weak, defective transducer.

Echo with 2000 ml Test

13. Adjust the time base to 50µs/div. Add 1950ml of water to the disposable container. This test will confirm that the transducer receiving circuitry is working properly for larger volumes.
14. Verify that there is an echo (>180mV) pulse ≈279µs past the falling edge of STRTXM (see Figure 72).

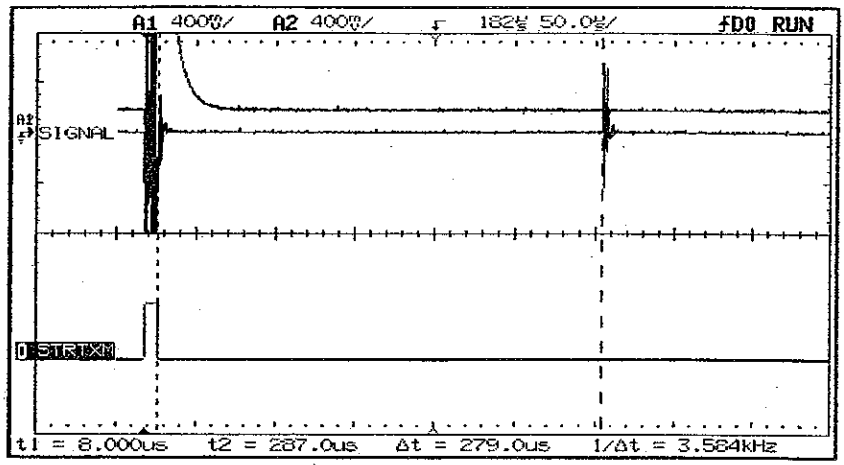


Figure 72

Removing The Transducer/Transducer Cap

Equipment Required

- No. 2 Phillips screwdriver
- Desoldering equipment (for transducer removal)

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Note: Review the contents of the Transducer/Transducer cap replacement parts kit (see the Replacement Parts List on page 64), to confirm which parts you may need to keep/discard during disassembly.

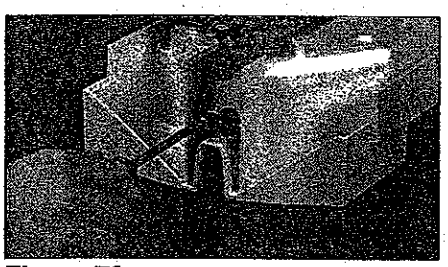


Figure 73

Procedure

1. Remove the rear enclosure per the Removing the Rear Enclosure procedure on page 39.
2. Desolder the transducer wire connections to PCB terminal mounts T1 and T2. This step is not necessary to replace the transducer cap.
3. Remove the two (2) 6-32x3/8" Phillips pan-head screws to separate the transducer and transducer cap from the enclosure as illustrated in Figure 73.

Installing The Transducer/Transducer Cap

Equipment Required

- No. 2 Phillips screwdriver
- Soldering equipment (for transducer removal)

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Procedure

1. If installing a new transducer, solder the shielding end of the transducer wire to T1, and the coax wire to T2 of the main PCB.
2. Using a non abrasive cloth dampened with 70% Isopropyl Alcohol, be sure to remove any remaining solder flux. Using a brush, apply a light layer of conformal coating onto the terminals of the transducer. Allow coating sufficient time to dry as called out by the manufacturer before further assembly.

Note: Conformal coatings protect the leads of the electronic components from corrosion. Coating the terminals of the transducer may prolong the life of the component.

3. Ensure that the transducer face is clean of any oil or dirt (use a non abrasive cloth dampened with 70% Isopropyl Alcohol). Place the transducer cap on top of the transducer.
4. Install the two (2) 6-32x3/8" Phillips pan-head screws and attach the transducer/cap to the front enclosure as illustrated in Figure 73. Ensure that the transducer cable will not get pinched when the rear enclosure is attached.
5. Install the rear enclosure per the Installing the Rear Enclosure procedure on page 40.
6. Perform the Functional Checkout procedure to ensure that all display and general Monitor functions are working properly.

Phototransistor

The phototransistor (ISO1 on the Display PCB) is a reflective optical sensor used to detect the presence of a disposable collection container. Power to ISO1 is provided by SENSPWR (refer to the display PCB schematic located at the end of this manual). When the disposable container cap is detected, Q1 is turned on, bringing CONSNS to ground.

Testing the Phototransistor

Equipment Needed

- 100MHz dual trace oscilloscope (w/ time base delay capabilities)
- Precision DC power supply

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Note: Before you test the phototransistor, perform the Testing the LCD Display procedure (on page 29) to verify that all LCD status indicators are functioning properly.

Procedure

1. Turn the CritiCore Monitor *ON* and ensure that the display assembly is fully closed (with the magnets resting on the attraction plates).
2. Verify that the *Check Container* status indicator is lit with no disposable collection container installed in the monitor. If the *Check Container* status indicator is still not on, there may be a problem with the main PCB (continue with the procedure).
3. Place an empty disposable collection container into the Monitor, and close the display assembly down onto the container. Verify that the *Check Container* status indicator turns off. If the *Check Container* status indicator remains lit, the phototransistor may be contaminated with oil or other foreign matter.
4. To clean the phototransistor, gently wipe the two lenses (see Figure 74) with a Q-tip dampened with 70% Isopropyl Alcohol.
5. Repeat step 3. If the *Check Container* status indicator remains lit, there may be a problem with the main PCB (continue with the procedure).
6. Verify that SENSPWR is providing the proper amount voltage. Refer to the Testing the Power Modules procedure on page 46 for testing SENSPWR.
7. If not already removed, remove the rear enclosure per the Removing the Rear Enclosure procedure on page 39. In that procedure, it is unnecessary to disconnect the display module.
8. Re-insert the hinge pins to temporarily secure the display module to the enclosure assembly
9. Configure a precision DC power supply to deliver an output of 4.00V @ 250mA, then turn the supply off. Carefully attach the positive lead to the TP1-+BATT test point on the main PCB. Attach the negative lead of the supply to TP2-GND test point on the main PCB.


Figure 74

Caution: If the polarity of the leads are reversed, fuse (F1) will blow. Double-check the polarity of the DC power supply leads before turning the supply on.

10. Without a disposable collection container in the Monitor, turn the power supply and the Monitor on.
11. Trigger off of CH1 (rising edge)of the scope connected to TP4 of the main PCB. Connect CH2 of the scope to TP17 of the main PCB. Set the main time base to 1ms/div., and CH1 and CH2 to 2.00V/div.
12. Verify that after ≈300µs from the rising edge of TP4, there is a ≈180µs pulse >3.5V (see Figure 75).

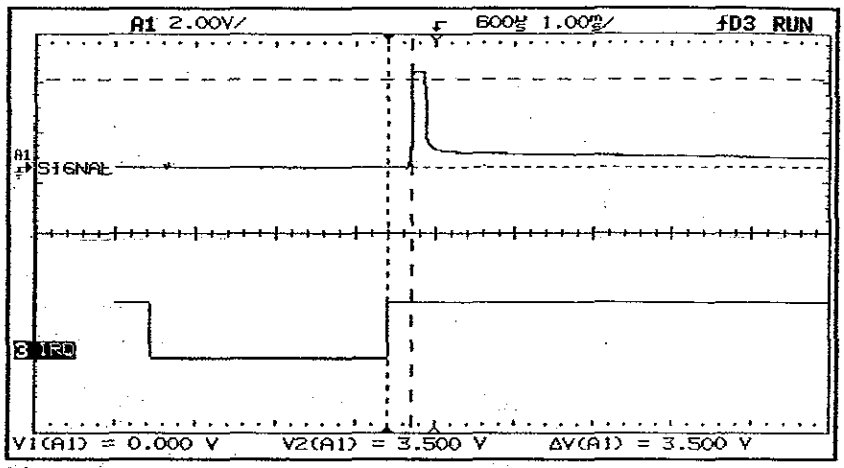


Figure 75

13. Place a disposable canister into the Monitor and close the display assembly onto the container cap. Verify that after ≈300µs from the rising edge of TP4, there is no ≈180µs pulse >3.5V. (see Figure 76)

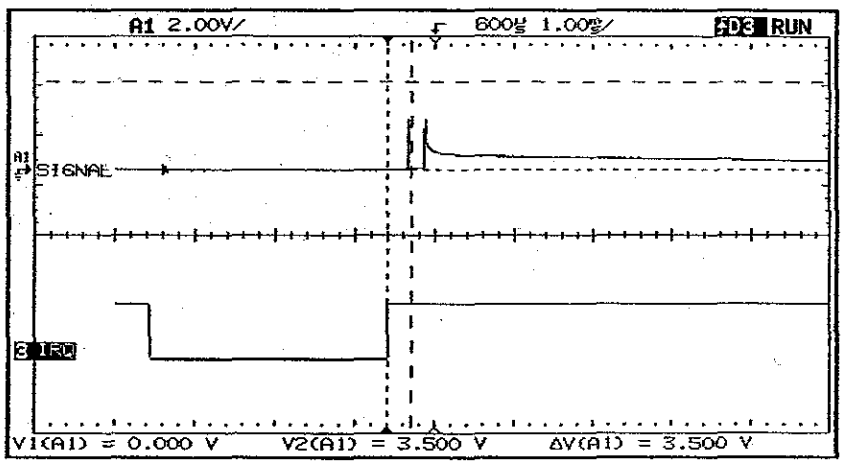


Figure 76

Tilt Sensor

To maintain volume measurement accuracy, the Bard *CritiCore Monitor* must remain level (< 3°). When the Monitor is tilted, the tilt sensor communicates to the microcontroller a *Not Level* condition. This will disable the *Container Volume* function until the Monitor is restored to a level condition.

Testing the Tilt Sensor

Equipment Needed

- 100MHz dual trace oscilloscope (w/ time base delay capabilities)
- Precision DC power supply

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Procedure

1. If not already removed, remove the rear enclosure per the Removing the Rear Enclosure procedure on page 39.
2. Re-insert the hinge pins to temporarily secure the display module to the enclosure assembly.
3. Configure a precision DC power supply to deliver an output of 4.00V @ 250mA, then turn the supply off. Carefully attach the positive lead to the TP1-+BATT test point on the main PCB. Attach the negative lead of the supply to TP2-GND test point on the main PCB.

Caution: If the polarity of the leads are reversed, fuse (F1) will blow. Double-check the polarity of the DC power supply leads before turning the supply on.

4. Ensure that the Monitor is standing upright and level.
5. Without a disposable collection container in the Monitor, turn the power supply and the Monitor on.
6. Trigger off of CH1 (rising edge)of the scope connected to TP4 of the main PCB. Connect CH2 of the scope to TP16-TILT of the main PCB. Set the main time base to 1ms/div., and CH1 and CH2 to 2.00V/div.
7. Verify that after ≈270µs from the rising edge of TP4, there is a pulse >3.5V (see Figure 77).

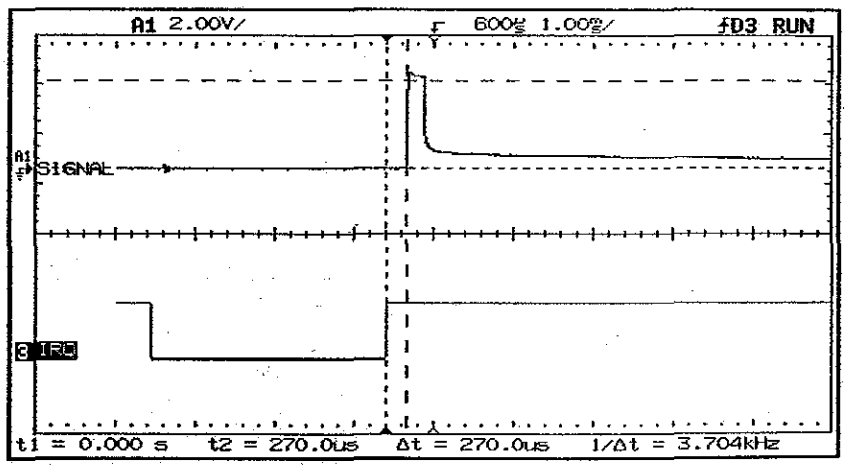


Figure 77

8. Carefully tilt the Monitor. Verify that after ≈270µs from the rising edge of TP4, there is no pulse >3.5V (see Figure 78).

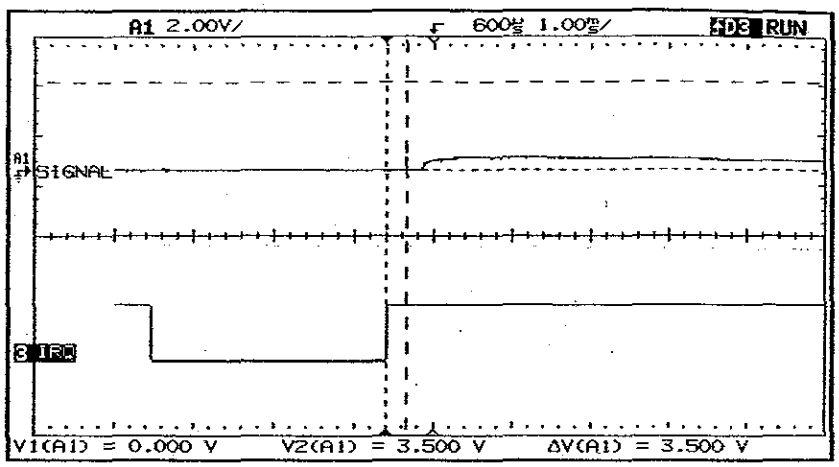


Figure 78

Temperature Electronics

The temperature-sensing circuit is comprised of the temperature jack on the display PCB and the sensitive analog circuit area located in the upper right region of the main PCB. The conversion of the resistance value of the thermistor into a temperature value occurs within the processor.

Testing the Temperature Electronics

Equipment Required

- 100MHz dual trace oscilloscope (w/ time base delay capabilities)
- Precision DC power supply

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Procedure

1. Perform the Testing the Temperature Jack procedure (page 27) to verify that the temperature jack is functioning properly, and is not causing intermittent readings.
2. Verify that +AD supply is providing the proper amount of voltage. Refer to Testing the Power Modules procedure (page 46) for testing +AD.
3. If +AD supply is out of tolerance, the main PCB may be damaged. Send the Monitor in for service (see page 3 for details), or refer to the Replacement Parts List (on page 64) to order a replacement main PCB. See the Main PCB section (page 58) for removal and installation procedures.
4. Refer to the Installing and Calibrating the Main PCB procedure on page 58 to verify that the Monitor is within calibration; re-calibrate if necessary.
5. If the Monitor cannot be calibrated, send the Monitor in for service or refer to the Replacement Parts List (on page 64) to order a replacement main PCB. See the Main PCB section (page 58) for removal and installation procedures.

Main PCB

If the main or display PCB's are replaced/exchanged, the Monitor must be re-calibrated for temperature accuracy. The Monitor PCB "set" consists of the main and display PCB together. This "set" must be calibrated to ensure accurate and consistent temperature readings.

Removing the Main PCB

Equipment needed

- No. 2 Screwdriver
- Needle nose pliers

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

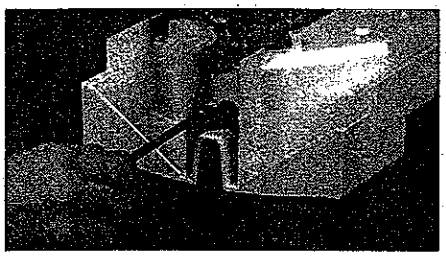


Figure 79

Note: Review the contents of the Main PCB replacement parts kit (see the Replacement Parts List on page 64), to confirm which parts you may need to keep/discard during disassembly.

Procedure

1. Disconnect all probes. Turn off the DC power supply and disconnect from the PCB.
2. Remove the two (2) 6-32x3/8" Phillips pan-head screws for the transducer, and pull out the transducer and transducer cap from the front enclosure as illustrated in Figure 79.
3. Remove the four (4) 6-32x3/16" Phillips pan-head screws which secure the main PCB to the front enclosure (see Figure 80). Disconnect the main PCB from the display PCB. Lift up and remove the main PCB.

Installing and Calibrating the Main PCB

Equipment needed

- No. 2 Screwdriver
- Needle nose pliers
- Precision Ohmmeter (accuracy to 0.1Ω)
- Potentiometer screwdriver (small flat blade)
- Torque seal (potentiometer sealant for electronic devices)
- Calibration plugs or precision decade box

Caution: The Bard *CritiCore Monitor* main and display PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

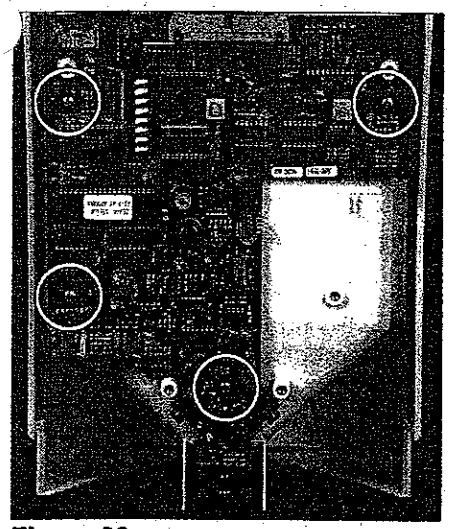


Figure 80

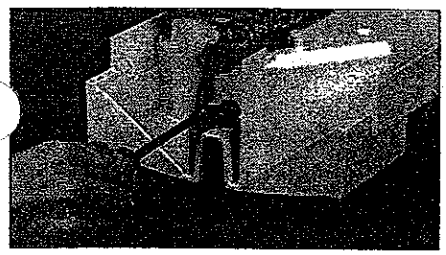


Figure 81

Procedure

1. Install the four (4) 6-32x3/16" Phillips pan-head screws and attach the main PCB to the front enclosure (see Figure 80).

Note: Ensure that there is no dirt, oil or contamination on the transducer cap or transducer.

2. Place the transducer cap onto the transducer. Install the two (2) 6-32x3/8" Phillips pan-head screws and attach the transducer/cap to the front enclosure as illustrated in Figure 81. Ensure that the transducer cable will not get pinched when the rear enclosure is attached.
3. Re-insert the hinge pins to temporarily secure the display module to the enclosure assembly.
4. Reconnect the display module ribbon cable to the Main PCB.
5. Have the following temperature calibration plugs ready:

Temperature Value in °F	[1]Resistance in Ω
52.0	4252.4
98.6	1354.7
102.2	1248.9
109.0	1073.9

[1]For proper calibration verify that the calibration plugs meet the resistance requirements above.

Note: To make a calibration plug, attach the appropriate precision resistance to a 3.5mm mono mini-phone plug. Do not use long (>2") leads to connect the resistance to the plug, as noise may be introduced into the sensitive analog circuitry.

6. Configure a DC precision power supply to deliver an output of 4.00V @ 250mA, then turn the supply off. Carefully attach the positive lead to the TP1-+BATT test point on the main PCB. Attach the negative lead of the supply to TP2-GND test point on the main PCB.

Caution: If the polarity of the leads are reversed, fuse (F1) will blow. Double-check the polarity of the DC power supply leads before turning the supply on.

7. Turn the Monitor on. Set the SW2 rotary switch on the main PCB to position 1. This will set up the display for temperature calibration: HEX output in the *Present Interval Output* window and °F in the *Bladder Temperature* window.
8. Connect the 52.0°F plug into the temperature jack on the display assembly.
9. Check for a value within (FB ≥ HEX value ≥ F9) in the *Present Interval Output* window (reference value of ≈ 52.0°F in the *Bladder Temperature* window). If the HEX value is not within parameters, then adjust RP2 on the main PCB until the value falls within the correct range. See the Main Circuit Board Map on page 63 for the location of RP2.
10. Replace the 52.0°F plug with the 102.2°F plug into the temperature jack on the display assembly.

11. Check for a value within (E65 ≥ HEX value ≥ E63) in the *Present Interval Output* window (reference value of ≈ 102.2°F in the *Bladder Temperature* window). If the HEX value is not within parameters, then adjust RP1 on the main PCB until the value falls within in the correct range. See the Main Circuit Board Map on page 63 for the location of RP1.
12. Repeat steps 8 through 11.
13. Repeat this process until the correct HEX values are obtained.
14. Replace the 102.2°F plug with the 98.6°F plug into the temperature jack on the display assembly.
15. Verify a value within (DC3 ≥ HEX value ≥ DC1) in the *Present Interval Output* window (reference value of ≈ 98.6°F in the *Bladder Temperature* window).
16. Adjust the DC precision power supply to 4.80V @ 250mA.
17. Verify a value within (DC3 ≥ HEX value ≥ DC1) in the *Present Interval Output* window (reference value of ≈ 98.6°F in the *Bladder Temperature* window).
18. Replace the 98.6°F plug with the 52.0°F plug into the temperature jack on the display assembly.
19. Verify a value within (10b ≥ HEX value ≥ E9) in the *Present Interval Output* window (reference value of ≈ 52.0°F in the *Bladder Temperature* window).
20. Replace the 52.0°F plug with the 109.0°F plug into the temperature jack on the display assembly.
21. Verify a value within (F81 ≥ HEX value ≥ F73) in the *Present Interval Output* window (reference value of ≈ 109.0°F in the *Bladder Temperature* window).

Note: If the correct HEX values are not obtained, repeat calibration steps 8 through 21. Otherwise, return the Monitor to Bard for repair (see page 3 for details).

22. Apply some torque seal to RP1 and RP2, taking care not to re-adjust the potentiometers when sealing them.
23. Set the SW2 rotary switch on the main PCB to position three (3).
24. Install the rear enclosure per the Installing the Rear Enclosure procedure on page 40.
25. Perform the Functional Checkout procedure to ensure that all display and general Monitor functions are working properly.

CritiCore Communications Module

The *CritiCore* Communications Module, is designed to permit communications between a computer or patient data management system and the Bard *CritiCore Monitor.*

Note: Refer to the Communications Module schematic when reading the paragraph below. Schematics are located at the end of this manual.

The Bard *CritiCore Monitor* provides raw data output on connector J4 of the main PCB. Connector J2 of the Communications Module connects to J4 of the main PCB, and data is transmitted across opto-isolators U2-U4. SER PWR (TP10) of the main PCB provides power for transmitted communications on pins one (1) and two (2) of U2-U4. U1, a 68HC705C9 microcontroller packages the raw data into the appropriate format and outputs the data onto U5, a RS232 driver/receiver. The output of U5 is connected to J3, which connects to a PC or other data management systems. D1, a green LED, is switched by Q1 and indicates the different states of communications. Vcc on the Communication Module is derived from U7, a precision 5V regulator. The 5V regulator is powered from a 6V DC power supply that connects to J1.

Testing the Communications Module

Note: The Communications Module PCB is conformal coated. Be sure that the meter leads are making contact with the component leads.

Consult the Bard CritiCore Communications Module Operator's Manual for details on installation, operation and data transmission format.

1. Ensure that Communications Module DC power supply connected to J1 is the Bard-recommended 6 ± 0.2V (250mA) isolated power supply.
2. Ensure that the SER PWR voltage at TP10 on the main PCB of the Monitor is within tolerance. Refer to the Testing the Power Modules procedure on page 46 for details.
3. Disconnect the CritiCore Monitor and the Communications Module from their respective power supplies. Locate fuse F1 on the Communications Module (see Figure 82) and connect an ohmmeter across F1.
4. Measure the resistance to verify that F1 < 2Ω. If F1 > 2Ω, F1 must be replaced. Follow the Removing and Installing the Communication Module Fuse (begin below). **Use an axial-lead 0.5 Amp fast-acting fuse when replacing F1.**
5. Connect the batteries to the *CritiCore Monitor* and the DC power supply to the Communications Module. Turn the Monitor *ON*.
6. Connect a voltmeter across the TP2 (GND) and TP1 (Vcc) test points on the Communications Module (see Figure 85). The voltage should measure 5 ± 0.1V.

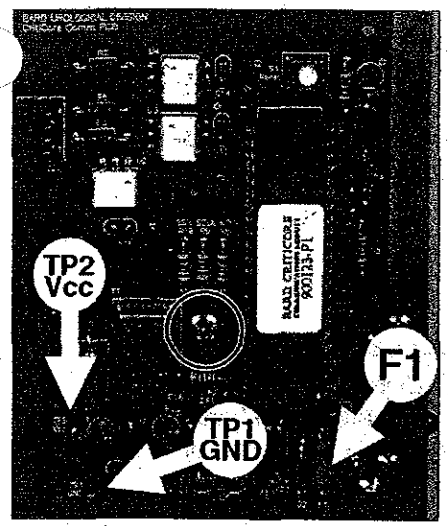


Figure 82

If the Communications Module passes the test procedure, and if functional problems persist, return the unit to Bard for service.

Removing the Communications Module Fuse

Equipment Needed

- Desoldering equipment
- No. 2 Phillips screwdriver

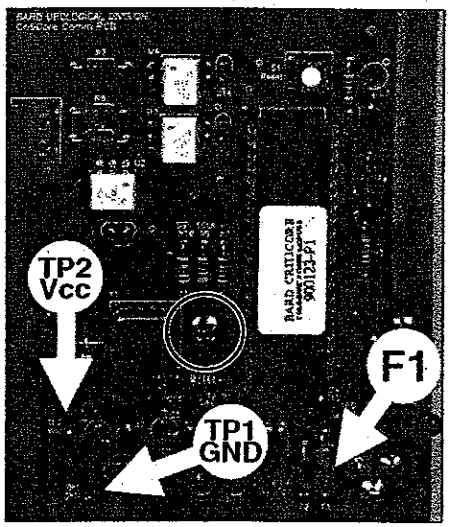


Figure 83

Caution: The Bard *CritiCore Monitor* main, display, and Communications Module PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Procedure

1. Remove the rear enclosure per the Removing the Rear Enclosure procedure on page 39.
2. Remove the one (1) 6-32x3/16" Phillips pan-head screw which secures the Communications Module to the front enclosure (see circle in Figure 83). Remove the Communications Module.
3. Locate the F1 leads on the back side of the PCB and carefully desolder them. Refer to the Figure 83 for the location of F1.

Note: When removing F1, be sure not to damage or remove the PCB pads.

Installing the Communication Module Fuse

Equipment Needed

- Soldering equipment
- No. 2 Phillips screwdriver

Note: Use an axial lead 0.5 Amp fast-acting fuse only.

Caution: The Bard *CritiCore Monitor* main, display, and Communications Module PCB's contain static sensitive electronic devices. Do not attempt to repair any internal components without proper ESD (Electro-Static Discharge) handling equipment. Failure to properly ground both your body and your work station could result in damage to the Monitor.

Procedure

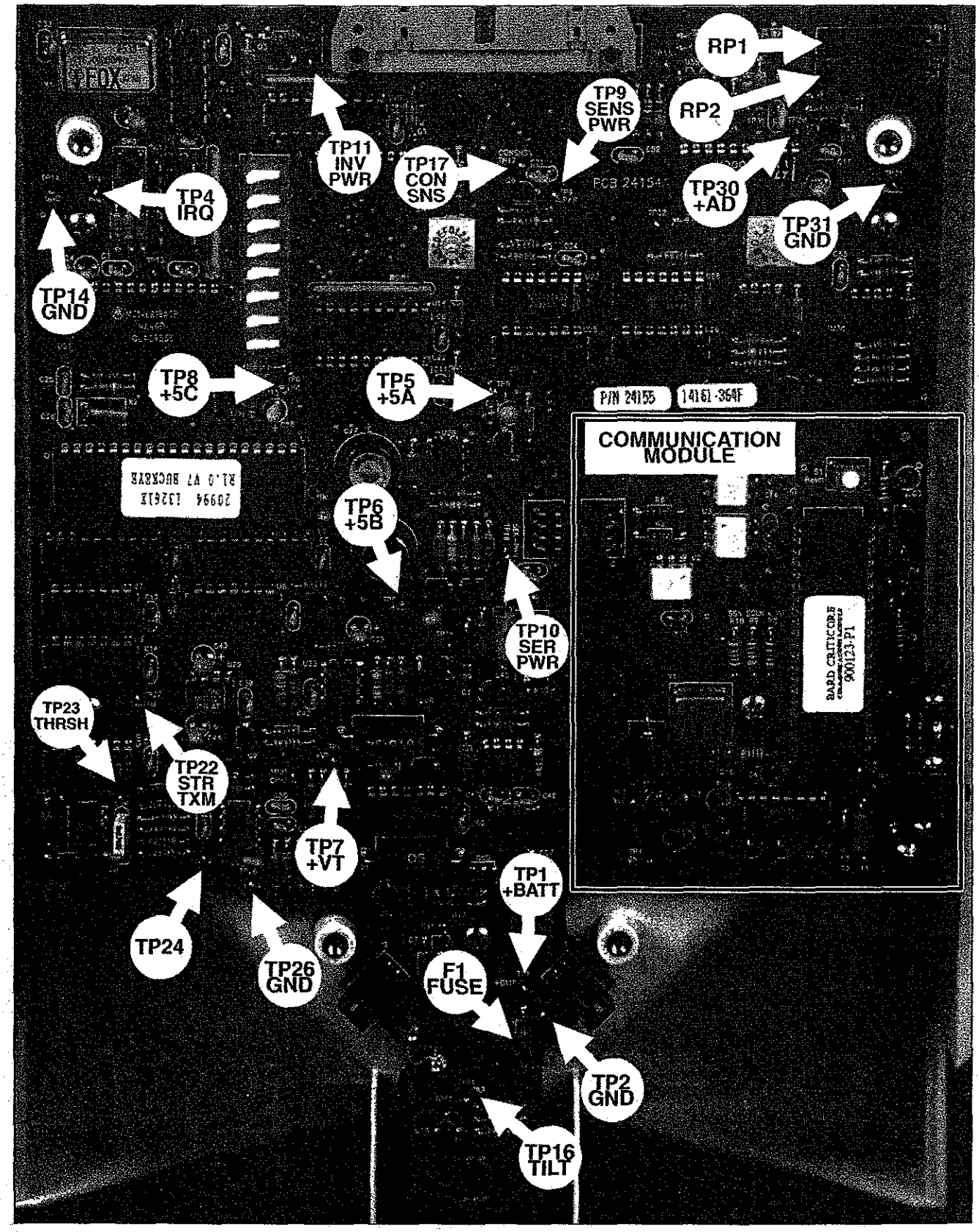
1. Solder the replacement fuse into location F1.
2. Using a non abrasive cloth dampened with 70% Isopropyl Alcohol, be sure to remove any remaining solder flux. Using a brush, apply a light layer of conformal coating onto the leads and pads of the fuse. Allow coating sufficient time to dry as called out by the coating manufacturer before further assembly.

Note: Conformal coating protects the leads of the electronic components from corrosion. Coating the leads of the fuse may prolong the life of the component.

3. Install the one (1) 6-32x3/16" Phillips pan-head screw that attaches the Communications Module to the front enclosure (see Figure 83).
4. Install the rear enclosure per the Installing the Rear Enclosure procedure on page 40.
5. Perform the Testing the Communications Module procedure to ensure that the module is functioning correctly.
6. Perform the Functional Checkout procedure to ensure that all display and general *CritiCore Monitor* functions are working properly.

Main PCB Component Map

The figure below shows a map to all the board-level components used to test and calibrate the Bard *CritiCore Monitor.*



Replacement Parts List

The following table contains all of the replacement parts available for the *CritiCore* Monitor.

Kit Part No.	Kit Description	Kit Contents	Quantity
CCP03200	*CritiCore Monitor* Membrane Switch Kit	Membrane Switch Panel Seal	1 4
CCP03300	*CritiCore Monitor* Bezel Top/Membrane Switch Kit	Bezel Top Membrane Switch Screws (SS PPH 4-40x1/4) Screws (SS PPH 6-32x1/4) Panel Seal	1 1 4 4 4
CCP03400	*CritiCore Monitor* LCD Panel Kit	LCD Zebra Retainer Zebra Strip (L) Zebra Strip (S) Washer, Nylon #2 Nut (hex, chamfered, ss (2-56)) Screw 2-56, 5/16 mach screw PPH ss.	1 2 2 2 9 9 9
CCP03100	*CritiCore Monitor* Bezel Enclosure Kit	Bezel Enclosure Assembly Screw 4-40, 1/4 mach screw PPH ss.	1 4
CCP03000	*CritiCore Monitor* Display Assembly	Display Assembly Snap Ring	1 2
CCP00300	*CritiCore Monitor* Handle Kit	Handle Shoulder Screw	1 2
CCP00200	*CritiCore Monitor* Arm Kit	Arm Assembly Shoulder Screw Arm Cover	2 2 2
CCP00100	*CritiCore Monitor* Hook Kit	Hook Dowel Pin, SS Hook Cover	2 2 4
CCP00400	*CritiCore Monitor* Hinge Pin Kit	Hinge Pin Snap Ring	2 2
CCP01000	*CritiCore Monitor* Front Enclosure Kit (includes Handle and Arms)	Front Enclosure Assembly Screw 6-32, 3/8 mach screw PPH ss. Screw 6-32, 3/16 mach screw PPH ss. Snap Ring	1 6 4 2
CCP02000	*CritiCore Monitor* Rear Enclosure Kit	Rear Enclosure Blank Insert Rear Door Rotary Knobs Rear Control Label Information Label Screw 6-32, 3/8 mach screw PPH ss. Snap Ring	1 1 1 2 1 1 4 2
CCP03500	*CritiCore Monitor* Temperature Jack Kit	Phone Jack O-rings	1 2
CCP01210	*CritiCore Monitor* Transducer Cap Kit	Transducer Cap	5

Kit Part No.	Kit Description	Kit Contents	Quantity
CCP01200	*CritiCore Monitor* Transducer Kit	Transducer Transducer Cap Screw 6-32, 1/4 mach screw PPH ss.	1 1 2
CCP01100	*CritiCore Monitor* Main PCB Kit	Main PCB Assy w/Tilt & Transducer	1
CCP02100	*CritiCore Monitor* Control Panel Door Kit	Rear Door	1
CCP02200	*CritiCore Monitor* Battery Door Kit	Battery Door	2
CCP04000	*CritiCore Monitor* Battery Assembly	Battery Housing Assembly Battery Cover Assembly Battery Cable Connector Battery Label Foam Pad	2 2 2 2 2
CCP02300	*CritiCore Monitor* Rotary Knob	Rotary Knob	2
CCP05000	*CritiCore Monitor* Packaging Kit	Shipping Box 18"x30" 1.5mil Poly Bag 5"x7" mil Poly Bag Foam Insert Top Foam Insert Bottom Corrugated Pad Battery Box Battery Box Divider	1 1 1 1 1 1 1 1
CCP00500	*CritiCore Monitor* Magnet and Attraction Plate Kit	Magnet Attraction Plate	2 2
CCP06000	*CritiCore Monitor* Operator's Manual	Operator's Manual	1
CCP06100	*CritiCore Monitor* Service Manual	Operator's Manual	1

Product Specifications

Measurement Ranges and Limits

Measurement	Range	Default
Bladder Temperature	50°F-110°F	N/A
Interval Output (Present and Prior Values)	0-9999 ml	N/A
Interval Length	5,10,15, 20, 30 minutes, 1 hour, 2 hours	1 hour
Container Volume	0-2100 ml	N/A
Flow Rate	0-9999 ml/hr	N/A
Time	12 (AM/PM) or 24 (military) hour mode	N/A
Alarms-general	Flashing display and selectable audible beep	N/A
Full Container Alarm	2000ml	N/A
High Temperature Alarm	86.0°F-110.0°F	101.0°F
Low Temperature Alarm	50.0°F-99.0°F	50.0°F
High Flow Rate Alarm	0-9999 ml/hr	9999 ml/hr
Low Flow Rate Alarm	0-9999 ml/hr	0 ml/hr

Instrument Specifications

Power Requirement

6 D-cell alkaline batteries
(3 in each battery pack)

Battery Operation

Approximately 6 months
Low battery indicator voltage: 2.6V
Unit Shut down Voltage 2.2V

Operating Temperature Range

50°F-100°F

Storage Temperature Range

35°F-120°F

Accuracy

Volume using urine ±5% and ±2ml

Temperature at 98.6°F ± 0.2 °F

Ultrasonic Measurement	Frequency	3.5MHz (nominal)
	Sampling rate	4 samples/sec.
Microcontroller	Type 68HC705. OTP 15.9K EPROM, 352 Bytes of RAM	
Dimensions	Height with arms up, (arms down)	18-1/4", (13- 1/8")
	Width	10"
	Depth (handle down)	6"
Weight	Shipping	11 lbs.
	In use	7 lbs.

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